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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
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20.01.2004

International Patent Classification (IPC) or both national classification and IPC
G01R33/34, G01R33/341, G01R33/3415

Applicant
THE UNIVERSITY OF HOUSTON SYSTEM

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ in written format
 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

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Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	4, 6, 7, 14, 16, 17, 24, 26-30, 34, 36, 37
	No: Claims	1-3, 5, 8-13, 15, 18-23, 25, 31-33, 35, 38-41
Inventive step (IS)	Yes: Claims	
	No: Claims	1-41
Industrial applicability (IA)	Yes: Claims	1-41
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V.

1 The following documents are referred to in this written opinion:

D1 = US 2002/0067167
D2 = US 5,585,723
D3 = WO 93/24848
D4 = US 5,565,778
D5 = EP 1 251 361
D6 = Wosik J et al, Proc. ISMRM 11, p. 2373 (2003)
D7 = EP 0 895 092
D8 = Chow MS et al, Proc. ISMRM 11, p. 2372 (2003)

2 Lack of novelty and/or an inventive step (Art. 33(2) and 33(3) PCT)

2.1 Independent claims 1, 11

Claim 1

- a) The subject-matter of **claim 1** would appear to lack novelty with respect to each of the documents D1-D6 for the following reasons.

For instance, document D1 discloses (references in parentheses referring to D1):

An MRI coil (the coil depicted in fig. 4) comprising:

- four members (any four adjacent strips 24 depicted in figs. 4-6, see also pars. [0029] and [0030]), each member including a superconducting layer (layers 241 and 243 in figs. 4, 5; see also par. [0030]),
- where the members are arranged to form a closed shape having four overlapping regions (see the side view of the strips shown in fig. 6; it is noted that, taking the clarification given under item 4.2 b) below into

account, the strips shown in fig. 6 can be considered to "form a closed shape" and the regions at the top and bottom of the strips where layers 243 are present can be identified as "overlapping regions");

- separating dielectric layers interposed between the superconducting layers at the overlapping regions to form built-in capacitors (gaps G shown in figs. 5, 6; the statement in par. [0031] according to which the HTS layer 241 on the first main surface of a strip and the thin-film electrode 243 (that may be made from HTS as well, see par. [0030]) on the second main surface of an adjacent strip "form another capacitor together" implies that gaps G are dielectric).

In a similar way, the lack of novelty can be shown with respect to each of the documents D2-D6 (see the passages of these documents cited in the search report (w.r.t. D2, D4, D5 it is noted that these documents disclose rf coils with built-in, interdigital capacitors wherein the presence of said capacitors implies that a dielectric is interposed between adjacent superconducting layers).

- b) Moreover, the subject-matter of claim 1 would appear to lack an inventive step with respect to document D7 for the following reasons.

D7 discloses an MRI coil (see the embodiment depicted in figs. 1 and 7) comprising four members arranged to form a closed shape having four overlapping regions (any two adjacent superconducting members 1, 1a to 1f and normally conductive rings 2a, 2b, see pars. [0032]-[0034]) and separating dielectric layers interposed at the overlapping regions to form built-in capacitors (dielectric layer 13 in fig. 7; see also par. [0038]).

Thus, the subject-matter of claim 1 differs from that of D7 only in that each of the four members includes a superconducting layer rather than only two of the four members as in D7.

The technical effect of each of the members including a superconducting layer is an increased sensitivity of the MRI coil since resistive losses (that result in

noise in the MR signal) in superconductors are small compared to normally conducting materials.

Therefore, the problem to be solved consisted in increasing the signal-to noise ratio (SNR) of the coil disclosed in D7.

Given this problem, the skilled person would consider the possibility of replacing normally conductive rings 2a, 2b of D7 by superconducting rings since this possibility and its benefits are well-known in the art. In this context, it is noted that members 1, 1a to 1f of D7 were made from a high temperature superconductor (HTS). Moreover, at the filing date of D7, HTS materials were merely available on planar, rigid substrates (see D7, par. [0018]) and rings 2a, 2b of D7 could not be constructed from HTS material. However, at the priority date of the present application, the possibility of fabricating HTS materials on flexible substrates and its benefits were well-known in the art (for instance, see the article by Malagoli et al cited in the search report).

Thus, it would appear that the skilled person would be tempted to replace normally conductive rings 2a, 2b of D7 by superconducting rings. Thus, starting from D7, the skilled person would arrive at the subject-matter of claim 1 without the exercise of any inventive skill.

- c) Moreover, the subject-matter of claim 1 would appear to lack an inventive step with respect to document D8 for the following reasons.

The subject-matter of claim 1 differs from that of D8 only in that the coil comprises four members including a superconducting layer rather than two members including a superconducting layer as in D8 (see D8, section "Materials" and fig. 1). Moreover, according to claim 1, the members are arranged to form four overlapping regions rather than two overlapping regions as in D8.

However, even D8 itself refers to the possibility of constructing an HTS phased array coil with four (or more) coils rather than two coils as in the example shown

in fig. 1 of D8 (see section "Conclusion", last phrase). Moreover, it is noted that constructing an HTS phased array coil with four (or more) coils involves the presence of four (or more) overlapping regions.

Therefore, it would appear that the skilled person would select the number of coils in the array disclosed in D8 solely in accordance with circumstances and arrive at the subject-matter of claim 1 without the exercise of any inventive skill.

Claim 11

The subject-matter of **claim 11** would appear to lack novelty with respect to each of the documents D1 and D7 for the following reasons.

For instance, document D1 discloses (references in parentheses referring to D1):

A hybrid MRI coil apparatus (the coil depicted in fig. 2) comprising:

- two superconducting members (any two adjacent strips 14 in fig. 2, see pars. [0027], [0028]), each member including a superconducting layer (layer 141 in fig. 3, see also par. [0028]);
- two metal members (rings 12 in fig. 2, see par. [0027]);
- separating dielectric layers (sapphire substrate 142 in fig. 3, see par. [0028]);
- where the superconducting members and the metal member are arranged to form a closed shape having four overlapping regions (see fig. 2) and the separating dielectric layers are interposed between the superconducting layers and the metal members at the overlapping regions to form built-in capacitors (see fig. 3 and par. [0028]).

In a similar way, the lack of novelty can be shown with respect to D7 (see the passages of this document cited in the search report).

2.2 Dependent claims 2-10, 12-41

The additional features of claims 2-10, 12-41 are either known from, or rendered obvious by the available prior art for the following reasons.

- | | |
|--------------------|--|
| Claims 2, 3, 5: | see the sapphire substrate 242 in fig. 6 of D1 and par. [0030]; |
| Claims 4, 6, 7: | the additional features are known from the embodiment derived from D7 in an obvious manner (see the objection against claim 1, item 2.1 b) above); |
| Claim 8: | see D3, figs. 12, 13; |
| Claims 9, 10: | see D5, fig. 22; |
| Claims 12, 13, 15: | see the sapphire substrate 242 in fig. 6 of D1 and par. [0030]; |
| Claims 14, 16, 17: | starting from anyone of documents D1 and D7, it would appear that the skilled person would select the substrate material solely in accordance with circumstances, without the exercise of any inventive skill; |
| Claim 18: | see D1, fig. 3; |
| Claims 19, 20: | see D7, figs. 9a, 9b; |
| Claim 21: | see D1, figs. 4-6; see also the embodiment which can be derived from D7 in an obvious manner (objection against claim 1, item 2.1 b) above); |
| Claims 22, 23, 25: | see the sapphire substrate 242 in fig. 6 of D1 and par. [0030]; |
| Claims 24, 26, 27: | the additional features are known from the embodiment derived from D7 in an obvious manner (see the objection against claim 1, item 2.1 b) above); |
| Claim 28: | see D7, fig. 7; |
| Claims 29, 30: | see D7, figs. 9a, 9b; |
| Claim 31: | see D1, figs. 2, 3; see also D7, figs. 1a, 7; |
| Claims 32, 33, 35: | see the sapphire substrate 242 in fig. 6 of D1 and par. [0030]; |
| Claims 34, 36, 37: | starting from anyone of documents D1 and D7, it would appear that the skilled person would select the substrate material solely in accordance with circumstances, without the exercise of any inventive skill; |
| Claim 38: | see D1, fig. 3; |
| Claims 39, 40: | see D7, figs. 9a, 9b; |

Claim 41: see D6, fig. 1.

Re Item VII.

3 Certain defects

- 3.1** According to Rule 5.1a (ii), documents D1-D8 should have been identified in the description and briefly discussed.
- 3.2** The independent claims should have been drafted in the two-part form in accordance with Rule 6.3(b) PCT, with those features known from the closest prior art (probably document D1 or D2) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).
- 3.3** According to Rule 6.2(b) PCT, reference signs should have been added to the claims.

Re Item VIII.

4 Lack of clarity, conciseness and support by the description (Art. 6 PCT)

- 4.1** The various definitions of the invention in two independent apparatus claims (claims 21 and 31 are considered to represent hidden dependent claims, see below) are such that the set of claims as a whole is not concise. The claims should have been drafted to include only one independent claim with dependent claims that cover features that are merely optional.
- 4.2 Claim 1**
 - a) The wording "MRI coil apparatus" covers arrangements not supported by the description, e.g. gradient coils, shim coils, etc. The description merely supports that said "MRI coil apparatus" is an **rf coil** (implicitly disclosed by referring to "resonators" in par. [0041]).

- b) The scope of the wording "the members [are] arranged to form a **closed shape**" (emphasis added) is unclear. Normally, the expression "a closed shape" means that said shape can be drawn using one continuous stroke. However, referring e.g. to the structure depicted in fig. 1B, it would appear that the sole "members" do not form a closed shape. Rather, said "members" **in combination with the "separating dielectric layers"** are "arranged to form a closed shape".

It is noted that this clarification was taken into account when comparing the subject-matter of claim 1 with document D1.

- c) Claim 1 would not appear to be supported by the description. The description merely supports (see par. [0041]) that
- the "members" are strips, and that
 - the strips are made of HTS deposited on dielectric substrates.

4.3 Claim 7

It is unclear which additional limitation is to be defined by claim 7 since claim 6 upon which claim 7 depends already defines that "two of the members are curvilinear" which would appear to have the same scope as the expression "two of the members are arcuate" defined in claim 7.

A similar objection applies to claims 17, 27 and 37 as well.

4.4 Claim 8

The expression "the substrate dielectric layers" lacks an antecedent definition when claim 8 refers back to claim 1.

A similar objection applies to claims 18, 28 and 38 as well.

4.5 Claim 9

Since no geometry of the MRI coil apparatus has been defined, it is not apparent what is to be understood by expressions such as "**exposed** portion", "**external** ... layer" and "**outer** surface".

4.6 Claim 11

- a) The objections raised under items 4.2 a) to c) similarly apply. With respect to the objection raised under item 4.2 c), it is noted that, with respect to claim 11, the description merely supports that the strips are made of HTS deposited on dielectric substrates or metal thin films deposited on dielectric substrates (see par. [0041]).
- b) The expression "**hybrid** MRI coil" should have been defined, e.g. in the same manner as in par. [0055] of the description.

4.7 Claim 14

In total, claim 14 refers to **four** substrate dielectric layers ("**two** of the substrate dielectric layers are rigid and **two** of the substrate dielectric layers are flexible"). However, this is inconsistent with claim 12 upon which claim 14 depends because claim 11 defines only **two** superconducting members wherein, according to claim 12, each superconducting member comprises a substrate dielectric layer.

A similar objection applies to claim 34 as well.

4.8 Claims 21, 31

- a) Claim 21 (claim 31) contains all features of claim 1 (claim 11). Therefore, claims 21 and 31 represent hidden dependent claims. Thus, claims 21 and 31 should have been drafted to manifest said dependency.
- b) Claims 21 and 31 would not appear to be supported by the description. The description merely supports that the plurality of coil apparatuses are arranged around the cavity **to form a birdcage resonator** (pars. [0053], [0054]).
- c) The term "the coil apparatus" lacks an antecedent definition.

4.9 Claim 41

It is not apparent what is to be understood by the expression "an **internal** end of the reservoir".

4.10 Description

- a) The statements in pars. [0001], [0070] and [0071] according to which certain documents are "incorporated by reference" should have been deleted.
- b) The statement referring to the "spirit" of the invention in par. [0071] results in doubts on the scope of the claims and should have been deleted.
- c) The reference signs in figs. 3A to 3D would appear to be inconsistent with pars. [0053] and [0054] (for instance, according to par. [0053], superconductor film 308 is interposed between dielectric films 304 and 306 which is not reflected in fig. 3A).
- d) The "method for acquiring MRI data" does not fall within the scope of the claims.